

he thus laid down the groundwork of the principle by which thanks to the practical improvements introduced soon after by Messrs. Elkington and Ruolz, electric gilding has gradually superseded the deleterious process of gilding by mercury. It was on this occasion that the grand prize of 3,000 fr. was awarded to de la Rive by the French Académie des Sciences.

A long and patient study of the phenomena which accompany the aurora borealis, and of their apparent connection, both with the properties exhibited by the flame of the Voltaic arc when under the influence of a magnet, and with the passage of the electric fluid through extremely rarefied gases, gradually led de la Rive to a new theory on the electric origin of the aurora. His theory was illustrated, and to a certain extent rendered plausible, by a series of beautiful experiments, reproducing in the lecture-room, through artificial means, the varied phenomena which characterise the aurora. These experiments were made first at Geneva, and some time after repeated at Paris before some of the most distinguished members of the French Institute.

But de la Rive's acquirements were not limited to science. The noble use he made of his fortune, the well-known hospitality which rendered his country house near Geneva for nearly forty years a centre of attraction to the most distinguished scientific and literary society of Europe, the high tone of his character, and the many services he rendered his country, more particularly when called upon in 1860 to use the influence of his name and position in obtaining from the English Government an effectual support for Switzerland against the threatened danger of French aggression, have secured to his memory a popularity which will long survive him.

VIVISECTION

THE advance of culture has brought with it an increased tenderness, and a more solicitous regard for the feelings of others, a regard extending slowly but surely to the feelings of animals also. It is to Science that this advance is mainly due. Only by gaining clear conceptions of natural sequences can men be brought to repress their native tendency to inflict pain as an exertion of power, or to feel ashamed of their thoughtless indifference when they see pain inflicted by others. It is demonstrable that Ignorance has ever been the most potent ally of Cruelty—on the small scale of boys torturing animals, and on the large scale of priests torturing heretics. The boy can only be made to feel that his act is vicious by having a vivid imagination of the fact that the animal organism is constructed like his own, and that the animal suffers as he suffers. The holy inquisitor, or enthroned persecutor, can only be made to see that his attempt to combat heresy by an *auto-da-fé*, is flagrantly at variance with all psychological experience. If the vast cruelties of persecuting "fanatics" have become intolerable in modern society, it is assuredly from no dogmatic teaching, no insistence on charity and love, but wholly from a moral enlightenment coming with a larger and more accurate understanding of natural sequences.

Not only has Science been a great agent in evolving the sympathies, and creating the intense desire to avoid giving pain, it has also created the means of alleviating pain. Is not the whole skill of the surgeon and the physician devoted to this end? How comes it, then, that physiologists who have to supply the surgeon and physician with accurate data, which they can only reach through Experiment, are supposed to be less sympathetic, less careful of the feelings of animals, than other men? A candid person would at once admit that this was not so; would admit that physiologists are quite as unwilling to inflict unnecessary pain as men of other classes. But

because Vivisection is one of the branches of physiological Experiment, and because when the details of such vivisections are reported, the public reading these, and wholly unacquainted both with the purpose and the procedure, is shocked at what seems needless cruelty, a cry of indignation naturally escapes, and the experimenter is regarded as indifferent to the sufferings of animals.

Every thinking man will admit that the feeling which prompts this indignant cry is highly laudable, and every man who understands the real case will declare that this feeling is misguided by ignorance. For what is the fact? The fact is, that in the vast majority of experiments no pain is inflicted, the operations that are painful being performed under chloroform, and thus the animal which has undergone an operation which would have killed it, had it not been insensible, awakens from the coma and begins tranquilly eating the food before it, as if nothing but a sleep had gone before! In some cases, indeed, pain is unavoidable; in some it is part of the phenomenon investigated. But this procedure is not chosen in wantonness, or the thoughtlessness of cruelty. The operation is justified by its purpose. If the tender surgeon inflicts pain, it is to save pain; if the physiologist inflicts pain, it is to widen knowledge, and thus alleviate pain on a wide scale. This is very different from the pain inflicted for the sake of sport; very different from the measureless misery of wars, inflicted to gratify national vanity or commercial greed. The physiologist does not inflict pain for his own pleasure; he overcomes his repugnance to it, as he overcomes his repugnance to the sights of the amphitheatre and hospital, nerved by a sense of ulterior good.

Here we meet the question raised by "X," whether man is justified in inflicting pain on animals to secure the good of fellow-men? I unhesitatingly answer, Yes. It is quite certain that man does assume and assert supremacy, eating, subduing, and exterminating animals, according to his needs; and I would ask whether human life would be practicable on this globe on other conditions? Why, there is seldom a spade thrust into the earth that does not cut some worm into writhing halves. If this be excused as a painful necessity, then also must vivisection be excused as a painful necessity; if the one is necessary to food, the other is necessary to knowledge. The physiologist is the judge of the necessity; on him rests the responsibility.

And now a word on the particular experiments which called forth X's protest. Obviously, since testing sensibility was the very purpose in view, Prof. Goltz, Prof. Foster, and myself were forced either to forego the inquiry, or to inflict more or less pain, and (if need were) excessive pain. Perhaps X. will say that such an inquiry ought not to have been pursued at such a cost. We thought otherwise. The point cannot be argued now; but I would illustrate what has been just said, by informing X. that even here anaesthetics were used where they could be used—when I removed the skin from the legs or the body of the frogs, or took out their brains, the animals were wholly insensible; and dreadful as it may seem to read of their limbs being pricked, and burned, we are assured that no pain whatever, not even the feeling of contact, was felt by the frogs.

In conclusion, I would urge upon the opponents of Vivisection, that it would be but fair to credit physiologists with the same repugnance to the infliction of pain as animates all enlightened classes; and to consider that if the repugnance is overcome in the pursuit of physiological knowledge, it does not the less exist, nor the less guide their conduct in other cases. For myself, I may be permitted to add that so far from acknowledging indifference to the feelings of animals, my sympathies are unusually active in the direction of animals; and it was my inability to witness pain which prevented my pursuing the

profession of a surgeon. Nevertheless, I have performed hundreds of experiments; and in the very rare cases where great pain was inevitable, the performance has been very distressing; but in all cases I should vehemently protest against the accusation that it was indifference or cruelty which enabled the experiments to be performed.

It is but right that I should acknowledge that Prof. Foster's communication of December 11 has shown me the error of my interpretation of his hypothesis.

GEORGE HENRY LEWES

I WISH briefly to point out the grounds upon which persons who are every bit as tender-hearted and as sympathetic with Nature as any ante-vivisectionist may claim to be, justify what X. condemns. In order that a part of the order of Nature may be ascertained, it is necessary that vivisection be largely practised. Those who practise it do so under a sense of solemn and even sacred responsibility. To suggest the word "cruelty" in connection with their proceedings is an injustice which only profound ignorance and inability to realise the motives of other men can excuse. There is no lack of sympathy with the probable sufferings of animals experimented upon in the mind of the physiologist. He suffers with them, and, as I know of one eminent experimenter, is sometimes disabled by emotion from continuing a research. But the recognition of a higher duty than regard to his own transient impulses or the brief sufferings of a lower animal usually completely controls the experimenter's thought and action, and the mutual suffering of both vivisector and vivisected becomes a sacrifice offered up on the altar of Science. My conviction is that, especially in dealing with such animals as the dog, the experimenter is no less constrained to inflict suffering at which his feelings revolt, by the presence of a noble ulterior motive, than is the surgeon who does not flinch from subjecting his brother-man to the certainty of the direst pain and the imminent risk of death.

No one has a right to *assume* that any other man, still less a whole body of men, is so fiendish as to take any pleasure in the evidences of an animal's sufferings, or so dull as not himself to feel distress when viewing those sufferings. If man is willing to suffer this mental pain for a high end, may he not exact some contribution from the animal world, who after all will benefit as well as he by the progress of Science. It is futile to bewail "the tremendous cost" at which such progress is made. Nature is inconceivably costly, if we choose to put things in that way, for no progress is made without endless suffering and immense destruction. Our very dinner-tables reek with the evidences of "the tremendous cost"—the pangs of slaughtered sheep, the groans of over-worked horses, the disfigurement of Nature's sacred face by agriculture—by which our corporeal means of progress is attained. And are we to be so inconsistent as to refuse to undertake the very highest occupation of humanity, the ascertainment of the order of Nature, because it adds to this "cost" of our existence?

The attempt to raise the question of the "rights" of the animal world in this connection seems to me to involve a very large assumption. I am not prepared to admit that animals have *any* "rights" in the sense that men have them. I could never subject a human being to vivisection for the purposes of scientific progress for much the same reason that, if starving among the Arctic snows, I should feel bound to starve with my companion, rather than kill and feed on him. The recognition of the inviolability of one's fellow-man except under conditions authorised by the community, is the very foundation of human society, and our relations to animals cannot in the remotest degree be assimilated to the relation thus established between man and man. Our conduct towards animals, as towards other living and even inanimate things, must be determined in quite

a different way, and by very different reasons. It is, I am inclined to believe, solely the consideration of how we ourselves are affected—whether injuriously or beneficially—by any particular line of conduct towards beings other than men, that can be allowed to guide us in such matters. Anything of the nature of cruelty is obviously thus condemned, and all wanton disrespect to the persons of both living and inanimate things, no less so.

Whilst thus refusing to admit anything like the "right" claimed by man from man, for lower animals, we are not led to regard them with less affection, nor to treat them with diminished tenderness. The conviction that they are ours with which to do what seems good to us, must even increase our disposition to kindly treatment.

Let cases of cruelty, whether from man to man, to woman or child, to horse, fox, or dog, rabbit or frog, be searched out, exposed, and the perpetrator condemned; but unless such persons as X. are prepared to accuse such men as Michael Foster and George Henry Lewes of specific acts of cruelty, they are not justified in making physiology the text for heart-rending appeals to a public imperfectly acquainted with the facts.

E. R. L.

THE THIRTY-TON STEAM-HAMMER AT THE ROYAL ARSENAL, WOOLWICH

FOR the past two years a stupendous undertaking has been in course of development at the Royal Arsenal, Woolwich, which bids fair to rival in point of solidity and grandeur of dimensions the works of ancient Egypt itself. We allude to the gigantic steam-hammer which is being erected in the gun factories, for the purpose of welding more swiftly and efficaciously than can possibly be done at present the coils of which such massive pieces of ordnance as our modern "Woolwich Infants" consist. The first phase in this undertaking, viz. the laying of an appropriate foundation for the hammer, has now been accomplished, and will be the subject of the present paper. The hammer itself, which is still in an unfinished condition, although rapidly approaching completion, will be treated of subsequently. It is out of the question, in the compass of a brief sketch, to give an adequate idea of all the labour and thought that has been expended upon these foundations, but an endeavour will be made to condense as far as possible the most interesting part of their history into a few words.

The foundations were commenced in a soft, spongy soil, which is the substratum upon which all the Arsenal has been built. A hundred piles of pine-wood shod with iron a foot square each, were driven into the earth so as to form an area of thirty feet square; and when the heads were sawn off to an even surface, their average length was 18 feet 4 inches. Concrete was then filled in all round to the top of the piles, and three cast-iron plates, weighing respectively 30, 55, and 30 tons, were placed upon the heads of the piles. But before proceeding further with the building up of the foundations, we must describe the nature of the castings alluded to. They were all run in the foundry of the Royal Gun Factories, and consisted of about one-fifth of Calder pig-iron to four-fifths of scrap metal containing old broken-up shell, and shot, &c. The metal, after being taken from a number of cupolas in which it was melted, was collected in huge reservoirs, called "sows," and kept in a liquid state during the time necessarily occupied in filling the sows by a quantity of firewood being piled on top, which of course was continually in a state of ignition. This process occupied some eight or ten hours. At a given signal the sows were tapped, and the iron run out into open sand moulds in the floor of the foundry. The removal of these gigantic castings to their destination was a matter involving considerable difficulty. Two sets of worn-out gun-trucks were laid down upon either side of the road, and planks